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(54) CONTROL DEVICE FOR VEHICLE

(57)Abstract:

PROBLEM TO BE SOLVED: To very accurately decide permissibility of an idling stop, in a vehicle idling-stopping an engine, when the vehicle is temporarily stopped, to restart the engine by a motor for restarting operation or the like.

SOLUTION: When a temporary vehicle stop condition is materialized, output voltage of a battery when an engine is restarted after an idling stop and an actual charge amount equivalent to a power energy quantity, which can be taken out from the battery to completion of starting of the engine, are estimated (S1 to S4) by considering an atmospheric temperature and a deteriorated condition of the battery, only when the actual charge amount is a prescribed value or more capable of well restarting the engine with the above estimated output voltage being reference voltage or more capable of driving an electric motor, the engine is idling stopped, except when in the above, the idling stop is inhibited (S5 to S7).

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CLAIMS [Claim(s)]

[Claim 1] It has an internal combustion engine and the electric motor which makes a dc-battery a power source as a source of power for car transit. It is the control unit of the car which operation of an internal combustion engine is suspended [car] on predetermined idle stop conditions, and said electric motor is driven [car] at the time of re-start of a car, and starts an internal combustion engine. It is based on the dc-battery charge condition presumed in consideration of the ambient temperature of a dc-battery, and a degradation condition. A dc-battery state estimation means to presume whether an output is possible for a dc-battery in power required for starting of the internal combustion engine which minds the drive of said electric motor at the time of re-start of the car after said idle stop, The control unit of the car characterized by having been based on the presumed result of said dc-battery state estimation means, and

constituting including an idle stop permission-or-denial judging means to judge the permission or denial of the shutdown of the internal combustion engine at the time of an idle stop.

[Claim 2] Said dc-battery state estimation means is the control unit of the car according to claim 1 characterized by presuming whether it is more than the reference voltage that needs the output voltage of a dc-battery for the drive of an electric motor, and is in the condition in which an output is possible beyond predetermined time about the drive power of an electric motor required for an internal combustion engine's starting.

[Claim 3] Said dc-battery state estimation means is the control unit of the car according to claim 2 characterized by presuming whether it is more than the reference voltage that needs the output voltage of said dc-battery for the drive of an electric motor based on a part for the open end electrical potential difference in the unloaded condition of the dc-battery at the time of an idle stop, and the voltage drop at the time of an electric-motor drive.

[Claim 4] The open end electrical potential difference of the dc-battery at the time of said idle stop is the control unit of the car according to claim 3 characterized by what is presumed based on the amount of charges and discharges presumed serially from the open end electrical potential difference detected at the time of starting after long duration neglect, and the addition value of the charge and discharge current detected after it.

[Claim 5] A part for the voltage drop of said dc-battery is the control unit of the car of any one publication of claim 2 characterized by what initial value is amended based on the degradation condition and ambient temperature of a dc-battery, and is presumed - claim 4.

[Claim 6] Said dc-battery state-estimation means is the control unit of the car of any one publication of claim 2 characterized by to presume whether it is in the condition in which an output is possible beyond predetermined time about power required for an internal combustion engine's starting - claim 5 based on the value which amended the amount of charges and discharges which presumed serially based on the degradation condition and the ambient temperature of a dc-battery from the open-end electrical potential difference which detected at the time of starting after long-duration neglect, and the addition value of the charge and discharge current which detected after it.

[Claim 7] The degradation condition of said dc-battery is the control unit of the car of any one publication of claim 1 characterized by what is presumed based on fall with the output voltage when discharging to the open end electrical potential difference and electric motor which were detected at the time of starting after long duration neglect - claim 6.

[Claim 8] Said dc-battery is the control unit of the car of any one publication of claim 1 characterized by being a plumbic acid dc-battery - claim 7.

DETAILED DESCRIPTION [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is equipped with an internal combustion engine and the electric motor which makes a dc-battery a power source as a source of power for car transit, suspends operation of an internal combustion engine at the time of an idle stop, and relates to the control unit of the car which said electric motor is driven [car] and starts an internal combustion engine at the time of re-start of a car.

[0002]

[Description of the Prior Art] In recent years, development of the car equipped with the internal combustion engine and the electric motor which makes a dc-battery a power source as a source of power for car transit is furthered.

[0003] In this car, operation of an internal combustion engine is suspended on fuel consumption or idle stop conditions predetermined [for the improvement in the exhaust air purification engine performance], and there is a thing of a method which said electric motor is driven [thing] and starts an internal combustion engine at the time of re-start of a car (refer to JP,9-76775,A).

[0004]

[Problem(s) to be Solved by the Invention] It has judged whether level with the charge level of a dc-battery able to restart an internal combustion engine by the electric motor at the time of re-start as conditions which suspend operation of

an internal combustion engine at the time of said idle stop is reached.

[0005] For example, it integrates with the battery voltage between predetermined time from the drive initiation time of a starter motor, and even if other condition precedents are satisfied, he is trying not to make an internal combustion engine stop automatically with the equipment shown in JP,58-140445,A, when a charge is judged to a dc-battery and it judges with charge being insufficient by comparing with the reference value which defined the integral value beforehand.

[0006] Moreover, by the above-mentioned method, since an internal combustion engine's automatic stay based on the judgment with the insufficient charge of a dc-battery serves as next time or subsequent ones, integrating with the charge and discharge current of a dc-battery, presuming a charge serially, and judging the permission or denial of automatic stay of an internal combustion engine is also considered.

[0007]

[Problem(s) to be Solved by the Invention] However, by the method which only presumes the charge of a dc-battery like before, and judges the permission or denial of automatic stay of an internal combustion engine, there was a case where an electric motor was actually driven and power required for an internal combustion engine's restart could not be taken out by the charge judged that is [restart] possible.

[0008] This invention was made paying attention to such a conventional technical problem, and aims to let the condition of a dc-battery offer the control unit of the car which actually drives an electric motor, presumes whether an internal combustion engine's restart is possible, and judged the permission or denial of automatic stay of an internal combustion engine.

[0009]

[Means for Solving the Problem] As shown in drawing 1, invention concerning claim 1 as a source of power for car transit With for this reason, an internal combustion engine Have the electric motor which makes a dc-battery a power source, and operation of an internal combustion engine is suspended on predetermined idle stop conditions. It is the control unit of the car which said electric motor is driven [car] and starts an internal combustion engine at the time of re-start of a car. It is based on the dc-battery charge condition presumed in consideration of the ambient temperature of a dc-battery, and a degradation condition. A dc-battery state estimation means to presume whether an output is possible for a dc-battery in power required for starting of the internal combustion engine which minds the drive of said electric motor at the time of re-start of the car after said idle stop, It is characterized by having been based on the presumed result of said dc-battery state estimation means, and constituting including an idle stop permission-or-denial judging means to judge the permission or denial of the shutdown of the internal combustion engine at the

time of an idle stop.

[0010] According to invention concerning claim 1, even if it is the same dc-battery charge level, with the ambient temperature and the degradation conditions of a dc-battery, internal resistance changes and output voltage and a current change.

[0011] Then, a dc-battery charge condition is presumed in consideration of the ambient temperature of a dc-battery, and a degradation condition, and it presumes whether an output is possible to an electric motor in power required for an internal combustion engine's starting based on the this presumed charge condition at the time of re-start of the car after said idle stop.

[0012] And when operation of the internal combustion engine at the time of an idle stop is suspended when a dc-battery is presumed that an output is possible in power required for an internal combustion engine's starting, and it is presumed that an output is not possible, this internal combustion engine's shutdown is forbidden and idle operation is made to perform.

[0013] Only when an internal combustion engine can be restarted good, while suspending idle operation and improving fuel consumption and the exhaust air purification engine performance by this, when an internal combustion engine cannot be restarted good, it can re-depart convenient by performing idle operation.

[0014] Moreover, it is characterized by presuming whether said dc-battery state

estimation means is more than reference voltage that needs the output voltage of a dc-battery for the drive of an electric motor, and invention concerning claim 2 is in the condition in which an output is possible beyond predetermined time about the drive current of an electric motor required for an internal combustion engine's starting.

[0015] According to invention concerning claim 2, in order to restart an internal combustion engine, it is necessary to continue generating torque required to output the electrical potential difference more than reference voltage indispensable for the drive of an electric motor first, and start an internal combustion engine by the drive of this electric motor till the completion of starting (high-order detonation).

[0016] Then, the permission or denial of the shutdown of the internal combustion engine at the time of an idle stop is judged by presuming whether a dc-battery is able to output the power which outputted the electrical potential difference more than said reference voltage, and balanced the torque for said engine starting beyond predetermined time.

[0017] A dc-battery condition required for making an internal combustion engine restart good can be presumed with high precision by this, and the permission or denial of an internal combustion engine's shutdown can be judged rationally. Moreover, it is characterized by presuming whether it is more than the reference voltage that needs the output voltage of said dc-battery for the drive of an

electric motor based on a part for the open end electrical potential difference in the unloaded condition of the dc-battery [invention / concerning claim 3 / means / said / dc-battery state estimation] at the time of an idle stop, and the voltage drop at the time of an electric-motor drive.

[0018] According to invention concerning claim 3, the output voltage V of a dc-battery is computed like a degree type. It can presume whether it is more than reference voltage V0 that needs a part for the output voltage V= open end electrical-potential-difference OCV-voltage drop Vd therefore and the output voltage V of the dc-battery at the time of restart of the internal combustion engine called for as mentioned above for the drive of the electric motor decided beforehand.

[0019] Moreover, invention concerning claim 4 is characterized by presuming the open end electrical potential difference of the dc-battery at the time of said idle stop based on the amount of charges and discharges presumed serially from the open end electrical potential difference detected at the time of starting after long duration neglect, and the addition value of the charge and discharge current detected after it.

[0020] Although it does not come out to carry out direct detection of the open end electrical potential difference since according to invention concerning claim 4 it cannot predict when it re-departs at the time of an idle stop and a dc-battery cannot be opened, the open end electrical potential difference and charge of a

dc-battery have close correlation.

[0021] Then, first, where connection between a dc-battery and electric system is wide opened at the time of starting after long duration neglect, an open end electrical potential difference is detected, the initial value of a charge is presumed from this open end electrical potential difference, and the charge at the time of an idle stop is presumed by what (it adds as minus at the time of plus and discharge at the time of charge) the addition value of the charge and discharge current detected after it to this initial value is added for.

[0022] And the open end electrical potential difference at that time can be presumed from the charge at the time of said idle stop. Moreover, invention concerning claim 5 is characterized by for the amount of [of said dc-battery] voltage drop amending initial value based on the degradation condition and ambient temperature of a dc-battery, and presuming it.

[0023] According to invention concerning claim 5, a part for the voltage drop Vd of a dc-battery is computed as the internal resistance R of a dc-battery, and a product with the discharge current I, and the discharge current I is abbreviation regularity (for example, 200mmA extent), but When a dc-battery deteriorates and the so-called polarization advances, while internal resistance R changes (increment) Since it changes also with ambient temperature, by amending in consideration of these, it can presume with high precision, as a result the open end electrical potential difference of the dc-battery at the time of said idle stop

can be presumed with high precision.

[0024] Moreover, it is characterized by to presume whether invention concerning claim 6 is in the condition in which an output is possible beyond predetermined time about power required for an internal combustion engine's starting based on the value which amended the amount of charges and discharges presumed serially based on the degradation condition and the ambient temperature of a dc-battery from the open-end electrical potential difference which detected said dc-battery state-estimation means at the time of starting after long-duration neglect, and the addition value of the charge and discharge current detected after it.

[0025] According to invention concerning claim 6, as mentioned already, the charge of the dc-battery at the time of an idle stop adds the addition value of the charge and discharge current detected after it to the initial value presumed based on the open end electrical potential difference detected at the time of starting after long duration neglect, and are presumed, but When the internal resistance of a dc-battery changes with the degradation condition of a dc-battery, and ambient temperature, the output power at the time of an electric-motor drive differs [said presumed charge] also on the same level.

[0026] Then, it can presume with high precision whether it is in the condition in which an output is possible beyond predetermined time about power required for an internal combustion engine's starting by amending said presumed charge

based on the degradation condition and ambient temperature of a dc-battery.

[0027] Moreover, invention concerning claim 7 is characterized by presuming the degradation condition of said dc-battery based on fall with the output voltage when discharging to the open end electrical potential difference and electric motor which were detected at the time of starting after long duration neglect.

[0028] Since according to invention concerning claim 7 the voltage drop when internal resistance increasing and discharging to an electric motor, i.e., fall with an open end electrical potential difference, will increase if degradation of a dc-battery progresses, a degradation condition can be presumed based on this fall.

[0029] Moreover, invention concerning claim 8 is characterized by said dc-battery being a plumbic acid dc-battery. According to invention concerning claim 8, a cost cut can be aimed at by using a plumbic acid dc-battery.

[0030]

[Detailed Description of the Invention] Below, the gestalt of operation of this invention is explained with reference to a drawing. Drawing 2 is the schematic diagram showing the configuration of the hybrid car concerning 1 operation gestalt of this invention. Thus, by this hybrid car, the electric motor (henceforth a motor generator) 2 which serves as a generator is directly linked with an internal combustion engine's (henceforth an engine) 1 output side. And a change gear 3 is connected to a motor generator 2, and it enables it to drive the axle 6 by the side of a driving wheel through a differential 5 with the driving

shaft 4 of the output side of this change gear 3.

[0031] Here, a motor generator 2 is used as a starting means to perform cranking of an engine 1, at the time of starting of an engine 1, or start of a car, and when re-departing from a car after the idle stop who stops an engine 1 automatically on predetermined idle stop conditions especially, in case an engine 1 is restarted automatically, it is used. Moreover, at the time of moderation operation, a motor generator 2 is operated as a generator, and it generates electricity by reviving the energy from a driving shaft 4 side, and is used for the charge to a dc-battery.

[0032] Drawing 3 is the schematic diagram showing the configuration of the electric power supply system in this operation gestalt. The high-voltage dc-battery 11 is a cell power source used as the power source of a motor generator 2 of rated 42 [V] extent in which charge and discharge are possible, for example, when a plumbic acid dc-battery is used, it is low cost. At the time of charge of this high-voltage dc-battery 11, i.e., the condition that generated output is obtained from the motor generator 2, the three-phase-alternating-current power generated by the motor generator 2 is changed into direct current power by the inverter 12, and is supplied to the high-voltage dc-battery 11 through a junction box 13. On the other hand, at the time of discharge, the discharge power of the high-voltage dc-battery 11 is transformed into three-phase-alternating-current power through a junction box 13 and an inverter 12,

and is supplied to a motor generator 2.

[0033] The low-battery dc-battery 14 is the plumbic acid cell of rated 14 [V] extent generally used as a power source of the mounted electric load containing an engine accessory load, and the electrical energy is conserved through DC to DC converter 15, after minding an inverter 12 and a junction box 13 from a motor generator 2.

[0034] Various service conditions, such as engine-speed Ne of a car, the vehicle speed VSP, and an idle switch signal, are inputted, and also an electronic control unit 16 The signal from the current sensor 17 which detects the generation-of-electrical-energy current IMG which occurred by the motor generator 2 and was changed by the inverter 12, The signal from the current sensor 18 which detects the charging current (or discharge current) IH to the high-voltage dc-battery 11, and the signal from the voltage sensor 19 which detects the terminal voltage VH of the high-voltage dc-battery 11 are inputted, and actuation of an engine 1 and a motor generator 2 is controlled based on these.

[0035] Next, control by the electronic control unit 16 is explained. Drawing 4 shows the flow chart of a main routine. At step 1, it judges whether stop conditions were satisfied temporarily. For example, it judges by whether brakes operation of the vehicle speed was carried out below at the low speed near 0.

[0036] when are judged with stop conditions having been satisfied temporarily [

said], and it progresses to step 2 and idle operation of an internal combustion engine is suspended, the output voltage VB of a dc-battery (the high-voltage dc-battery 11 and the following -- the same) when driving a motor generator 2 after that and restarting an engine 1 is presumed. It presumes with the flow chart specifically shown in drawing 5 mentioned later.

[0037] At step 3, it judges whether the output voltage VB of the dc-battery at the time of said presumed engine restart becomes more than reference voltage V0 [required for the drive of a motor generator 2].

[0038] At step 3, when judged with output voltage VB becoming more than reference voltage V0, it progresses to step 4 and the real charge SOCR of a dc-battery is presumed. Here, it is equivalent to the charge charged as power energy which can be taken out from a dc-battery, and the real charge SOCR is presumed with the flow chart shown in drawing 6 specifically mentioned later.

[0039] At step 5, it judges whether the real charges SOCR of said dc-battery are zero or more predetermined values SOCR. Here, said predetermined value is set as the amount of energy when outputting the power of the motor generator 2 required for starting of an engine 1 beyond the predetermined time to the completion of starting by the value considerable the bottom.

[0040] And when judged with the real charges SOCR of a dc-battery being zero or more predetermined values SOCR, it progresses to step 6, the shutdown of an engine 1 is permitted, and idle operation is suspended.

[0041] When the output voltage VB of a dc-battery is judged at step 3 on the other hand to be less than [reference voltage V0], When the real charge SOCR of a dc-battery is judged to be less than zero predetermined value SOCR, at step 5 or the drive of a motor generator 2, respectively [difficult] Or although a motor generator 2 drives, starting an internal combustion engine good judges that it is difficult, it progresses to step 7, and it forbids the shutdown of an engine 1, and it makes idle operation perform.

[0042] Next, the presumed routine of said output voltage VB is explained according to the flow chart of drawing 5. At step 11, the present open end electrical potential difference OCV1 is presumed based on the charge SOC 1 of the present dc-battery detected by the charge presumption routine of drawing 7 . Since-like proportionally correlation is between Charge SOC and the open end electrical potential difference OCV as shown in drawing 8 , it asks for the open end electrical potential difference OCV1 by retrieval from the map created based on this property.

[0043] At step 12, a part for a voltage drop Vd is presumed in consideration of the degradation condition of the dc-battery called for by the ambient temperature of the dc-battery detected with a coolant temperature sensor etc., and the charge presumption routine of said drawing 7 . Since the internal resistance R of a dc-battery will increase if it decreases according to the rise of ambient temperature and degradation progresses, it searches correction factors

K1 and K2 from each map (refer to drawing 9 and drawing 10) created based on these inclinations, multiplies initial value R0 (value at the time of ordinary temperature without degradation) by said correction factors K1 and K2, and, specifically, computes them like a degree type.

[0044] The drive current I of R=R0, K1, and K2 electric motor is detected by said current sensor 18, and a part for a voltage drop Vd is computed like a degree type.

[0045] At Vd=R-I=R0, K1, K2, and the I step 13, the output voltage VB of a dc-battery is computed like a degree type based on a part for said open end electrical potential difference E1 and a voltage drop Vd.

[0046] VB=OCV1-Vd, next the routine which presumes the real charge SOCR of said dc-battery are explained according to the flow chart of drawing 6 .

[0047] At step 21, the charge SOC 1 of the present dc-battery detected by the charge presumption routine of drawing 7 is read. Based on the ambient temperature and the degradation condition of a dc-battery, correction factors K3 and K4 are searched with step 22 from each map. Here, the output current decreases and the real charge SOCR becomes small, so that it is equivalent to the amount of power energy which can be taken out from a dc-battery by the completion of starting and the internal resistance of a dc-battery becomes large.

[0048] At step 23, the real charge SOCR is computed by carrying out multiplication amendment of said correction factors K1 and K2 and the

correction factors K3 and K4 set up similarly to said presumed charge SOC 1. Correction factors K1 and K2 may be used instead of correction factors K3 and K4 in simple.

[0049] Next, the presumed routine of said charge SOC 1 is explained according to the flow chart of drawing 7. At step 31, it judges whether it is at the starting time after long duration neglect. After suspending operation last time, specifically, it detects by having detected the condition that 3 - 4 hours or more passed because water temperature is below ordinary temperature, and the power source having been turned on.

[0050] At step 32, said voltage sensor 19 detects the terminal voltage of a dc-battery. Since the relay which connects a dc-battery and a power circuit is turned off at this time, the this detected terminal voltage serves as the initial value OCV0 of an open end electrical potential difference.

[0051] At step 33, the initial value SOC 0 of a charge is presumed based on the initial value OCV0 of said open end electrical potential difference. What is necessary is just to specifically ask by retrieval from the map shown in drawing 8 .

[0052] At step 34, the terminal voltage VB when setting to ON the relay which connects a dc-battery and a power circuit, and discharging a high current by using an electric motor as a load is detected. At step 35, a part for a voltage drop Vd 0 is computed by subtracting said terminal voltage VB from the initial

value OCV0 of said open end electrical potential difference.

[0053] At step 36, the degradation condition (degradation percentage of completion) of a dc-battery is presumed by retrieval from the map shown in drawing 11 based on a part for this voltage drop Vd 0 etc. Specifically, the internal resistance of a dc-battery presumes that degradation is advancing greatly, so that the amount of [Vd / 0] voltage drop is large. In addition, although Current I is abbreviation regularity (for example, 200mmA(s)) at the time of said discharge, the internal resistance R0 of a dc-battery is computed by doing a division with the current I which detected a part for a voltage drop Vd 0 by the current sensor 18, and you may make it presume the degradation condition of a dc-battery based on this internal resistance R0.

[0054] At step 37, the current amount SOC 1 of charges and discharges is computed by integrating the charge and discharge current I (it subtracting at the time of plus and discharge at the time of charge) which flows by the charge and discharge of a dc-battery to the initial value SOC 0 of the charge presumed at said step 33.

[0055] As mentioned above, in order to perform the permission-or-denial judging of idle operation of the engine 1 at the time of an idle stop based on the ambient temperature of a dc-battery, and the charge condition of the dc-battery presumed in consideration of the degradation condition, Only when an engine 1 can be restarted good, while idle operation is suspended and improving fuel

consumption and the exhaust air purification engine performance, when an engine 1 cannot be restarted good, it can re-depart convenient by performing idle operation.

DESCRIPTION OF DRAWINGS [Brief Description of the Drawings]

[Drawing 1] The block diagram showing the configuration of this invention

[Drawing 2] The block diagram of the supplying power system of the hybrid car concerning 1 operation gestalt of this invention

[Drawing 3] The block diagram of the electric power supply system of a hybrid car same as the above

[Drawing 4] The flow chart which shows the main routine of the control in the gestalt of operation same as the above

[Drawing 5] The flow chart which shows the routine which presumes the dc-battery output voltage at the time of engine restart

[Drawing 6] The flow chart which shows the routine which presumes the dc-battery real charge at the time of engine restart

[Drawing 7] The flow chart which shows the routine which presumes a current charge

[Drawing 8] Drawing showing the charge of a dc-battery, and the relation of an open end electrical potential difference

[Drawing 9] Drawing showing the ambient temperature of a dc-battery, and the

relation of a correction factor K1

[Drawing 10] Drawing showing the degradation condition of a dc-battery, and the relation of a correction factor K2

[Drawing 11] Drawing showing the relation of the part for a voltage drop and the degradation condition of a dc-battery

[Description of Notations]

1 Internal Combustion Engine (Engine)

2 Electric Motor (Motor Generator)

11 High-Voltage Dc-battery

12 Inverter

13 Joint Box

15 DC-DC Converter

16 Electronic Control Unit

17 Current Sensor

18 Current Sensor

19 Voltage Sensor